THE WEATHER AND CIRCULATION OF OCTOBER 1959

A Predominantly Cold, Wet Month in the United States

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1. SOME FEATURES OF THE GENERAL CIRCULATION

The 700-mb. circulation in the western Northern Hemisphere during October 1959 was characterized by a complete cycle in the 5-day mean zonal index at middle latitudes. Figure 1 shows that the zonal index reached a minimum during the 5 days centered October 5, rose steadily to a peak value of 12.8 meters per second in the period centered on October 19, and then declined rapidly again to below normal values during the last week of the month.

Despite this cycle, the long-wave pattern remained remarkably persistent during the month. The most persistent feature was the deep trough in the central Pacific (fig. 2) which fluctuated only slightly about its mean position. The low center in this trough moved gradually northward during the month as the blocking which dominated the first, or low-index, half of the month retrograded from the Bering Sea to the Kamchatka Peninsula. This evolution is shown in figure 3, the 15-day mean 700-mb. circulation for each half of October.

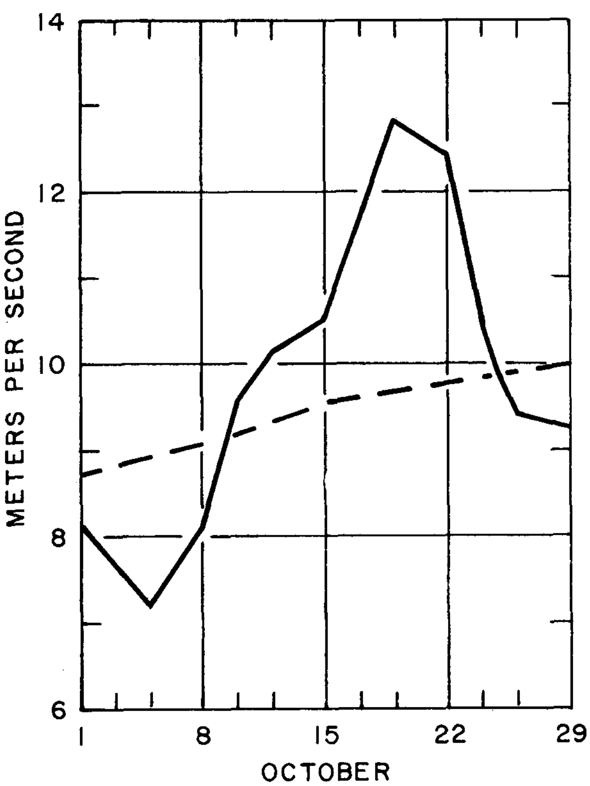


FIGURE 1.—Time variation of temperate-latitude zonal index (average strength of zonal westerlies in meters per second between 35° N. and 55° N.) at 700 mb. from 0° westward to 180° longitude for October 1959. Solid line connects 5-day mean zonal index values (computed three per week and plotted at middle day of 5-day period), and dashed line gives corresponding normal.

Figure 3 also shows that slow eastward progression of the ridge near the northwestern coast of North America and the trough downstream in the central United States occurred from the first to the second half of the month as the zonal index increased. More striking was the change in anomalous flow along the west coast of North America, as shown by the dotted lines in figure 3. The meridional character of this flow during the first half of the month was representative of the northerly steering which carried very cold air over the Middle and Far West. By contrast, in the latter half of the month the northerly component of the anomalous flow shifted from the area of the Continental Divide to the Mississippi Valley, bringing cold air into the eastern half of the United States.

As might be expected in view of the persistent long-wave pattern, the cycle in the zonal index was largely related to changes in amplitude. However, the rapid increase in index around mid-month was not accompanied by rapid progression of the trough and its associated cold air in the central United States. A regional breakdown of the hemispheric zonal index to include only the continental portion between 55° W. and 125° W. reveals little change between the half-monthly and full-monthly indices. For this area the mean zonal index for October 1–15 was 9.1 m.p.s.; for October 16–30, 8.8 m.p.s.; and for October 1–30, 9.0 m.p.s. During the first half of the month, when the zonal index for the western Northern Hemisphere was lowest, the mean index over North America at middle latitudes was highest. It is obvious, therefore, that the major changes in the strength of the westerlies must have occurred in the oceanic areas. This is clearly seen in the northward shift of negative 700-mb. height anomalies in the mid-Pacific and mid-Atlantic, as shown by the 15-day mean 700-mb. charts (fig. 3).

In Europe during October the general circulation underwent the first great change since May 1959 when a strong blocking High became established over the British Isles [1]. For six months 700-mb. heights averaged above normal in northwestern Europe as a center of positive anomaly oscillated between southern Scandinavia and Great Britain along the track shown in figure 4.

As a corollary, it may be noted that during this period the Bermuda portion of the Atlantic subtropical High was dominant, while the Azores portion, when evident, existed only at low latitudes. The result was a predominant southerly wind component in the eastern Atlantic, as typified by figures 1 and 2A, and warm dry weather in the British Isles and western Europe [2]. In sharp contrast, figure 2B shows the Azores portion of the Atlantic subtropical High well above normal near Spain with a strong

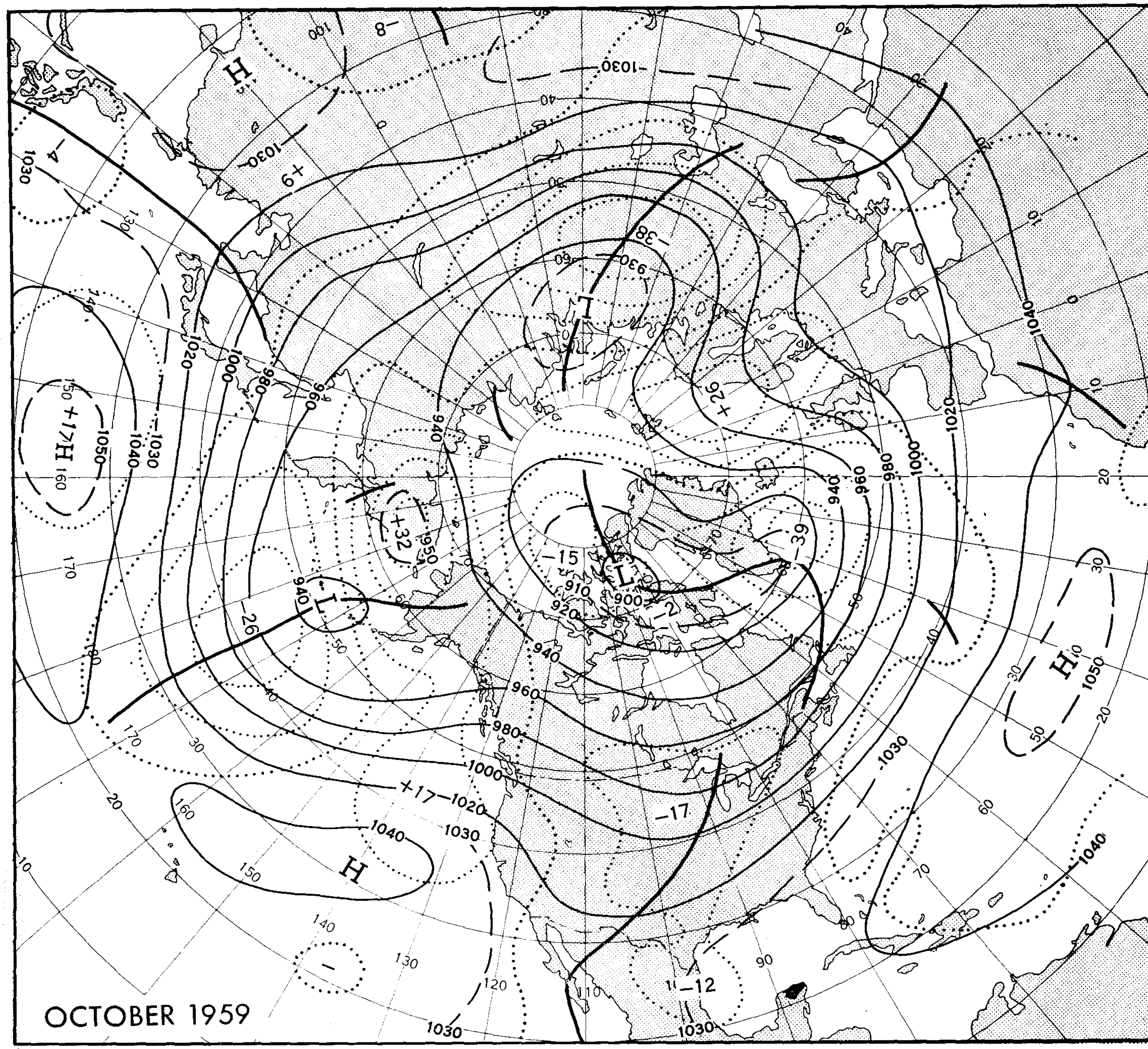


FIGURE 2.—Mean 700-mb. height contours and departures from normal (both in tens of feet) for October 1959. Deep mid-Pacific vortex and blocking to the north were important factors influencing North American weather.

band of confluence between it and the Icelandic Low. This configuration was associated with fast westerlies across northern Europe as shown by figure 3B, more in the manner suggested by the axis of maximum 700-mb. wind speed on the normal for October (given by the dashed line in fig. 5). This change is more dramatically highlighted by the difference in 700-mb. height anomaly between the first and second halves of October, as much as −920 feet in the Norwegian Sea and +630 feet in the northeastern Atlantic (fig. 6).

It should be noted that blocking was still a dominant feature of the circulation at high latitudes during the second half of October, as shown by the +310-ft. height anomaly (fig. 3B) near Novaya Zemlya. It would appear at first glance that blocking had merely progressed from the Norwegian Sea. However, since the migration of blocking is usually a retrogressive process, it is more likely that part of the blocking in the Bering Sea mentioned earlier (fig. 2A) retrograded toward northern Russia. It is also possible that this blocking surge was enhanced initially by warm air advection from the northeastern Atlantic into the Arctic during the first half of the month.

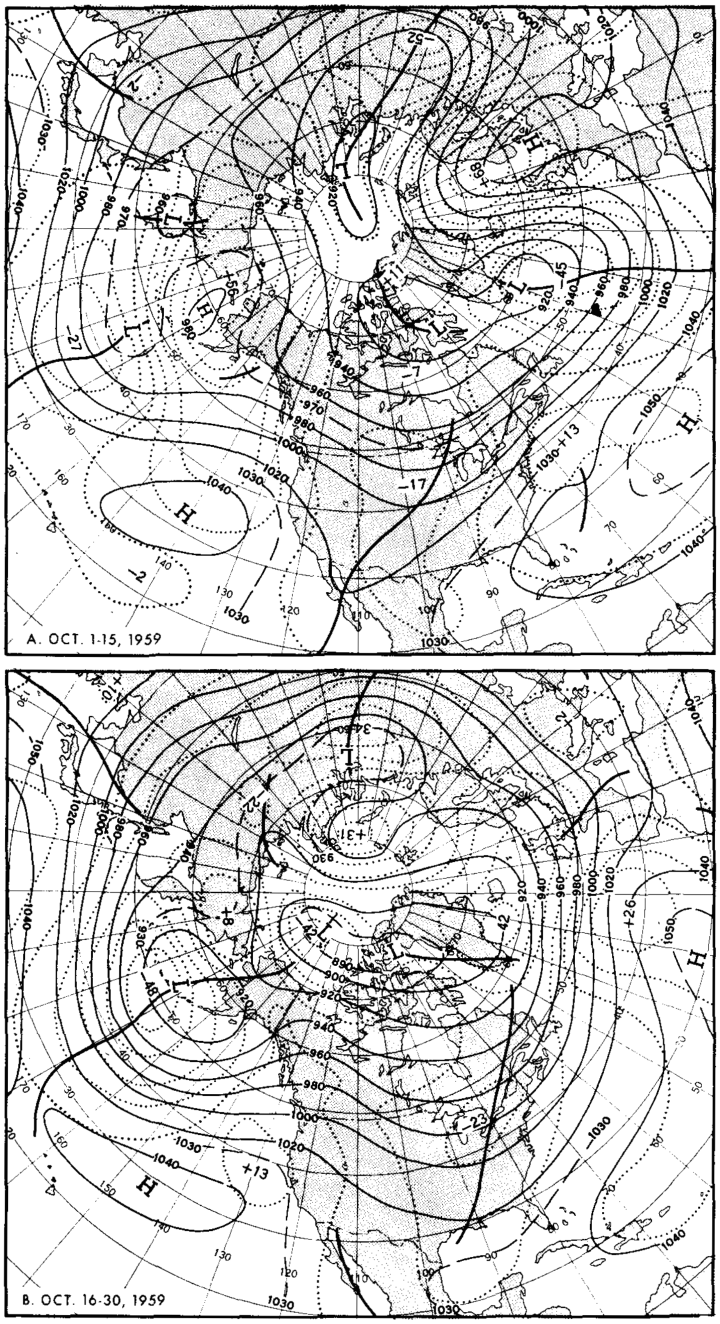


FIGURE 3.—Fifteen-day mean 700-mb. height contours and departures from normal (both in tens of feet) for (A) October 1-15, 1959, and (B) October 16–30, 1959.

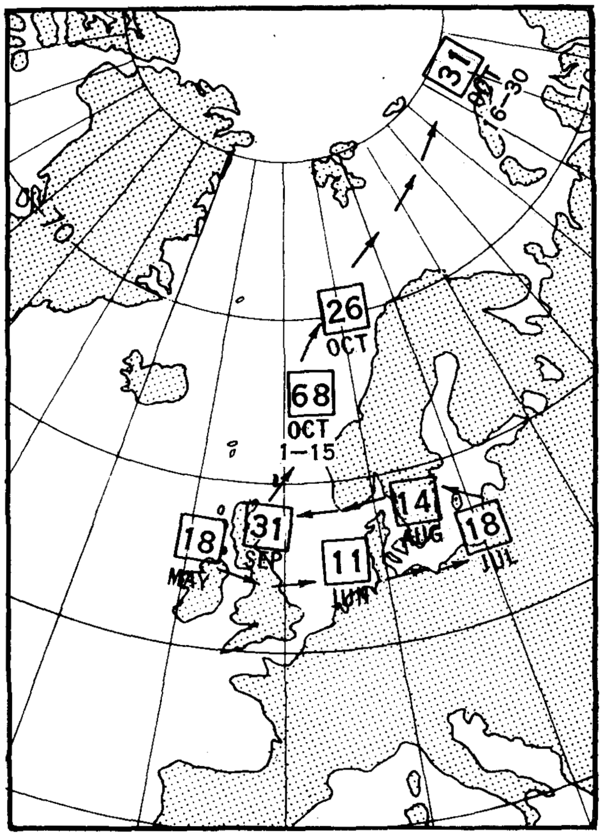


FIGURE 4.—Position and intensity of 30-day mean center of positive 700-mb. height anomaly over western Europe from May to October 1959, including 15-day mean anomalies for October. Number in square is the height anomaly in tens of feet for the month indicated below it.

2. WEATHER IN THE UNITED STATES

TEMPERATURE

The temperature regime over the contiguous States of the United States during October 1959 was characterized by a slow eastward migration in the anomaly picture throughout the month, as highlighted by a series of weekly temperature anomaly maps (fig. 7). These show a more or less uniform advance as colder than normal air masses invaded farther eastern positions with a gradual increase in temperature anomaly in the West and a decrease in the East. Below normal temperatures prevailed throughout most of the month in the central half of the nation. In the Far West the increase in temperature to the degree shown in figure 7D was associated with persistent anticyclonic conditions aloft in that area. After the initial polar outbreak (fig. 7A), Pacific anticyclones were dominant as the 700-mb. ridge-trough system (fig. 3) moved slowly eastward, bringing warm air masses into the West and cold polar air progressively farther east.

In the central and eastern parts of the country the abnormally cold weather was related in part to the unusually cold air mass source region near Hudson Bay. Although mean 700-mb. heights were only slightly below normal in this area, the thickness of the layer between 1000 and 700 mb. averaged considerably below normal for the month (fig. 8). In addition, in the eastern half of the country, the maximum westerlies were well south of their normal position (fig. 5), allowing migratory cyclones to introduce frequent outbreaks of polar air from central Canada. Note how perturbations from the Pacific (fig. 9) were steered around the periphery of the cold dome, generally following a path just north of the axis of maximum 700-mb. wind speed (fig. 5).

The pattern of 700-mb. height departure from normal for the month (fig. 2) appears well correlated with the monthly mean temperature anomaly pattern (fig. 10A), except in the East and Southeast where heights were

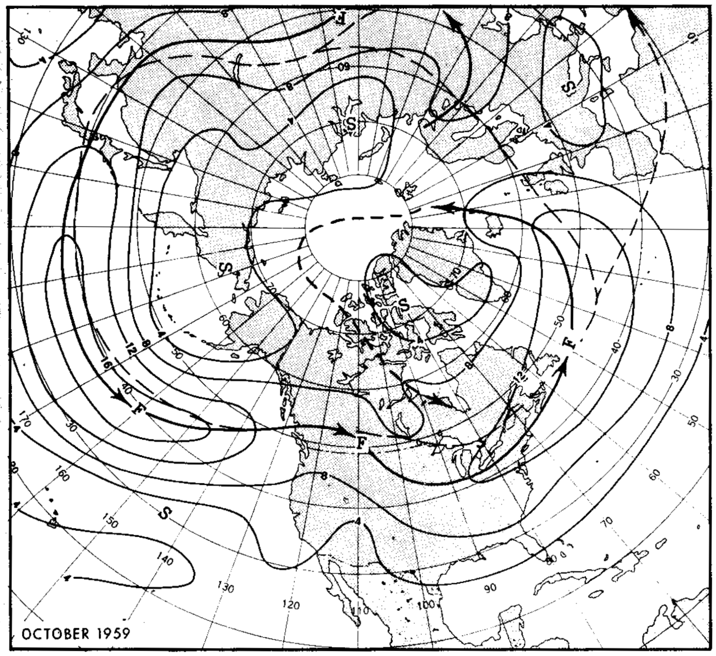


FIGURE 5.—Mean 700-mb. geostrophic wind speed (meters per second) for October 1959. Heavy solid lines indicate primary axis of 700-mb. jet stream, and thin, dashed lines the normal October position. "F" and "S" designate wind speed maxima and minima. Note the secondary jet around the polar vortex indicated by the heavy, dashed arrow.

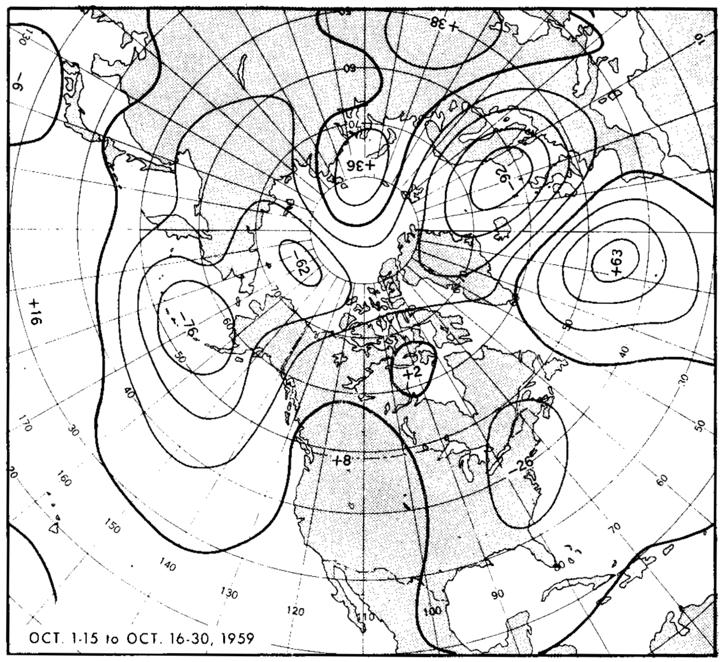


FIGURE 6.—Change in 700-mb. height anomalies (tens of feet) from October 1–15 to October 16–30, 1959. Areas of greatest change were in northern Pacific and western Europe, where relaxation of blocking occurred.

slightly below normal but temperatures above normal. However, this apparent discrepancy can be related to the southerly anomalous flow, advecting warm air masses from the Gulf of Mexico intermittently throughout the period.

Locally, October proved to be a month of extreme weather throughout the contiguous United States. Early in the month, while the Middle and Far West were establishing low temperature records for early fall, daily records for maximum temperatures were being broken from the Ohio Valley to New England (fig. 7A). In the central portion of the country, where below normal temperatures persisted throughout the month, Milwaukee, Wis. had its second coldest October on record, and Topeka, Kans. reported the coldest October in 35 years. By the end of the month new daily minimum records were being established in the Northeast (fig. 7E) while many new daily maximum records, in excess of 90 degrees, were reported in Arizona, New Mexico, Nevada, and California.

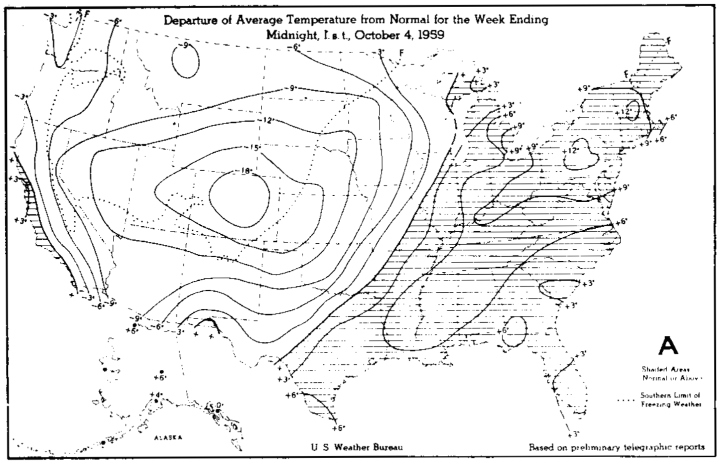
PRECIPITATION

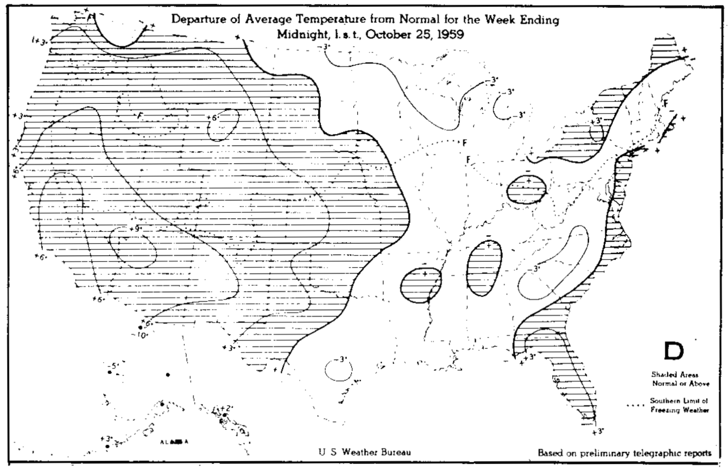
Precipitation was normal or above throughout the country except in California and Nevada, where little or none fell (fig. 10B). Light precipitation fell in a belt from Washington and Oregon eastward to South Dakota. Subsidence associated with persistent anticyclonic conditions and maintenance of a storm track well to the north combined to produce the record dryness in California and Nevada and resulted in an extension of the forest fire season. Several fires were raging near Eureka, Calif. at the end of the month.

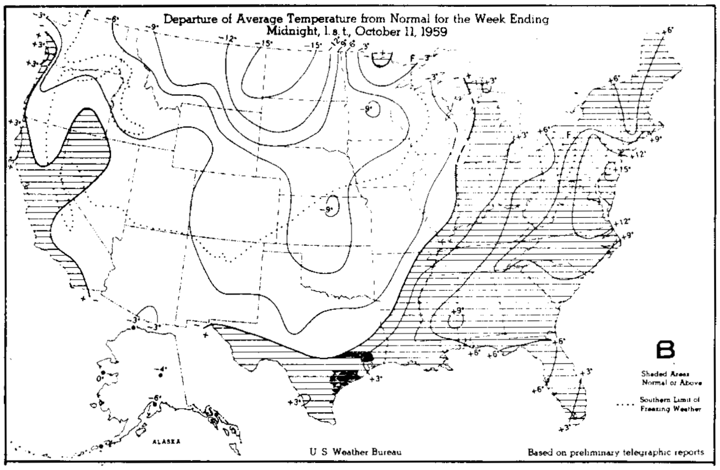
Most of the excess precipitation occurred along the slowly moving boundary of sharply contrasting air masses, particularly in the southern Great Plains and the Southeastern States. The quasi-stationary character of much of the frontal activity involved is shown by figure 11, the number of days with fronts during the month. A line connecting the maxima, from the northern Great Basin southeastward through Texas to the Gulf of Mexico and then northeastward to southern New England, outlines the mean boundary of the cold air. In addition, two tropical storms contributed additional rainfall from Florida to North Carolina, causing extensive flooding in the Carolinas where general rains had already produced considerable amounts.

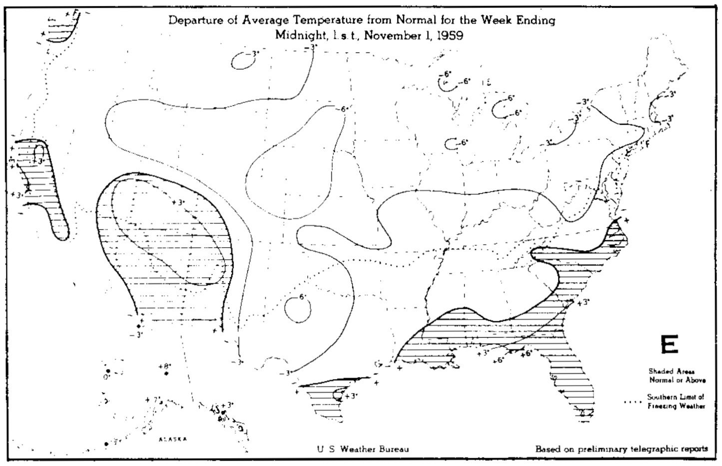
When one considers that October is normally a fair, dry month for most of the United States, the precipitation records established become more spectacular. Record amounts of precipitation in Texas, Oklahoma, and Kansas ranged from 11.38 inches at Dallas, Tex. to 6.37 inches at Concordia, Kans. From New Orleans, La. to Norfolk, Va., precipitation records for October were broken. Representative amounts which set new records are 12.09 inches at Apalachicola, Fla. and Columbia, S.C., 9.60 inches at Greensboro, N.C., and 9.39 inches at Macon, Ga.

In southern New England record daily precipitation, such as 4.45 inches at Hartford, Conn. on October 23–24, was responsible for flood conditions on the Connecticut River. As in New England, frontal rains set new precipitation records for October at Marquette and Sault Ste. Marie, Mich., and near records at Milwaukee, Wis. and Detroit, Mich.









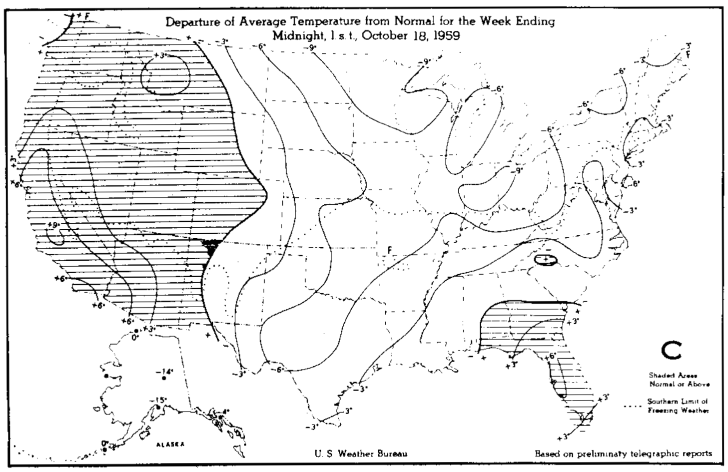


FIGURE 7.—Departure from normal of average surface temperature (° F.) for weekly periods ending (A) October 4, (B) October 11, (C) October 18, (D) October 25, and (E) November 1, 1959. (From *Weekly Weather and Crop Bulletin, National Summary*, vol. XLVI, Nos. 40–44, Oct. 5, 12, 19, 26, Nov. 2, 1959.)

3. TROPICAL STORM ACTIVITY

ATLANTIC

Three tropical storms developed during October in widely scattered areas, one east of the Leeward Islands, one in the central Gulf of Mexico, and one in the western Caribbean Sea. Their tracks are shown in figure 12A.

The major storm, Hannah, first observed near 21° N., 57° W. on September 29, moved rapidly northwestward to about 200 miles west of Bermuda by 0000 GMT of October 2. It then recurved, following a path around the periphery of the mean subtropical High (fig. 3A) in the central Atlantic. Hannah's most distinguishing feature was that it retained its tropical circulation for 9 days in a long trajectory across the central Atlantic to the Azores before becoming extratropical.

Tropical storm Irene, first detected in the central Gulf of Mexico on October 7, was of very short duration and might not have been of completely tropical origin. It seems to have developed in an area of cyclonic shear on a stationary front extending from Illinois to the central Gulf of Mexico. Simultaneous with the origin of Irene was the development of a deep Colorado Low which brought a fresh outbreak of polar air into the lower Mississippi Valley. This reduced Irene to a weak extratropical wave on the polar front within 48 hours, but not before it had produced heavy rains, particularly in northwestern Florida and in Georgia.

Tropical storm Judith was first detected as a tropical depression between Yucatan and Cuba on October 17. According to Haggard [3] and others, there is a definite maximum of tropical storm development in the western

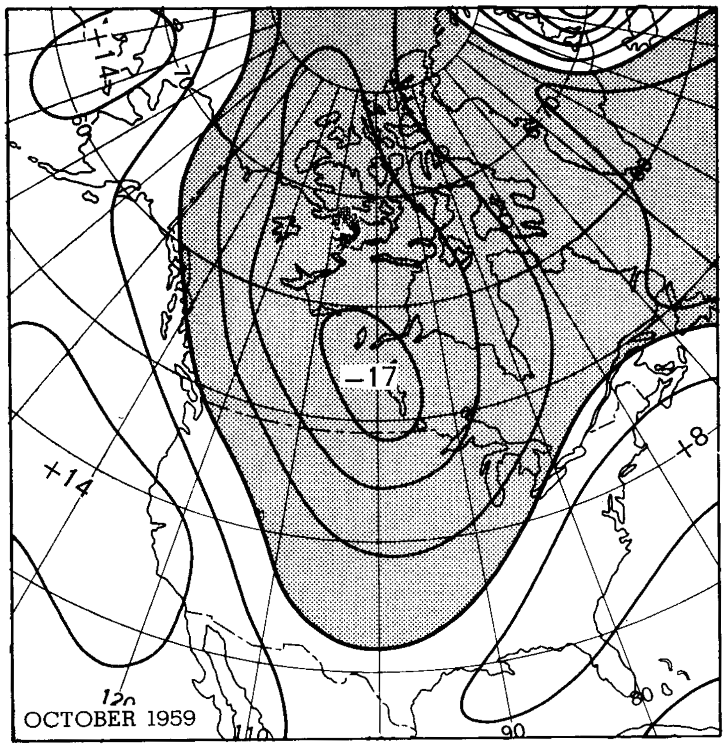


Figure 8.—Departure from normal of mean thickness (1000–700 mb.) for October 1959, with subnormal values shaded. Isoline interval is 50 feet, and centers are labeled in tens of feet.

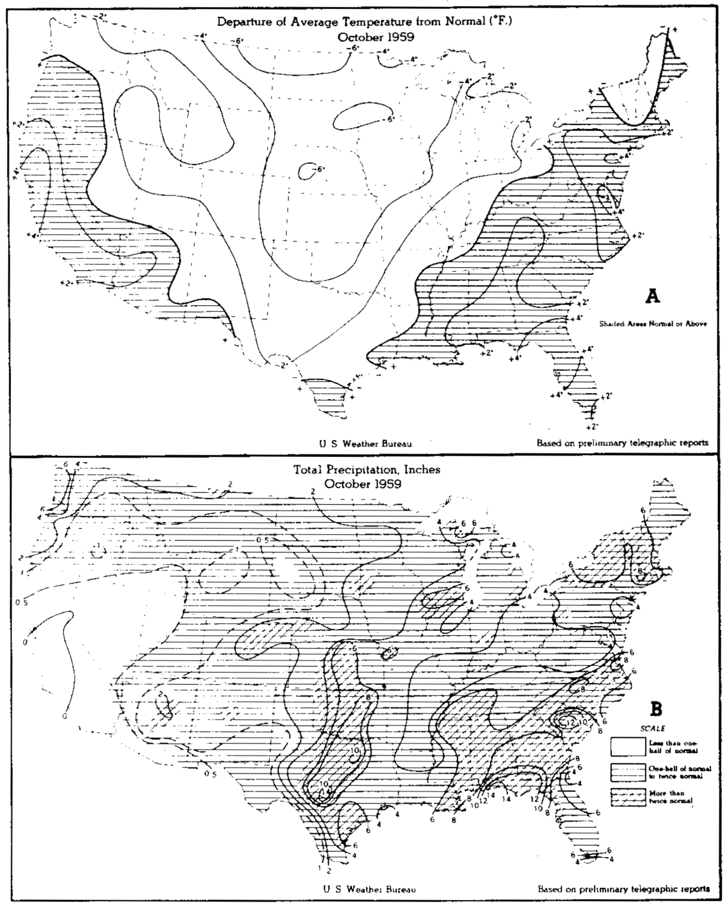


Figure 10.—(A) Monthly mean surface temperature departure from normal (° F.), and (B) total precipitation (inches), both for October 1959. (From *Weekly Weather and Crop Bulletin, National Summary*, vol. XLVI, No. 44, Nov. 2, 1959.)

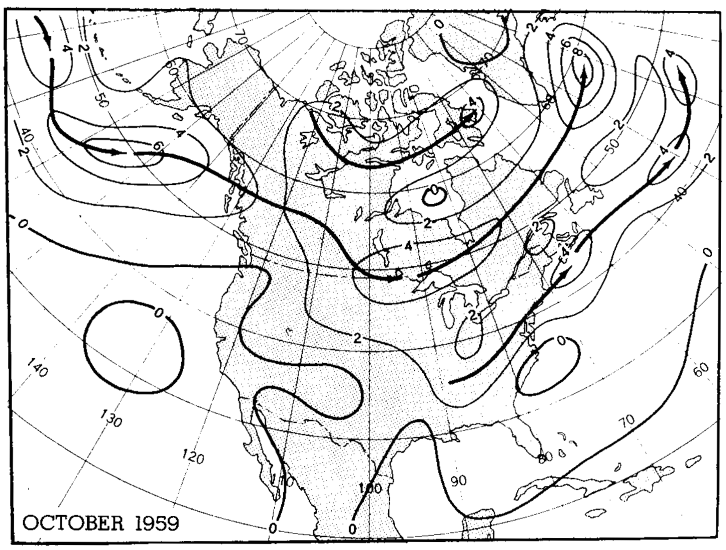


Figure 9.—Frequency of cyclone passages (within 5° squares at 45° N.) during October 1959. Well-defined cyclone tracks are indicated by solid arrows.

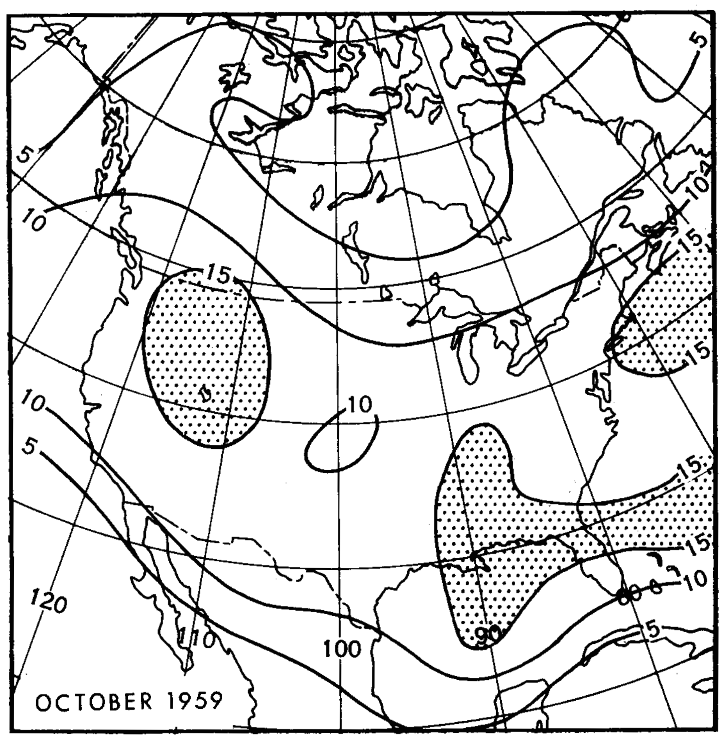


Figure 11.—Number of days in October 1959 with fronts of any type within unit squares (with sides approximately 500 miles). All frontal positions are taken from *Daily Weather Map*, 1:00 p.m., est. Areas with fronts on 15 or more days are stippled. Quasi-stationary fronts were frequent in the Great Basin and the northeastern Gulf of Mexico.

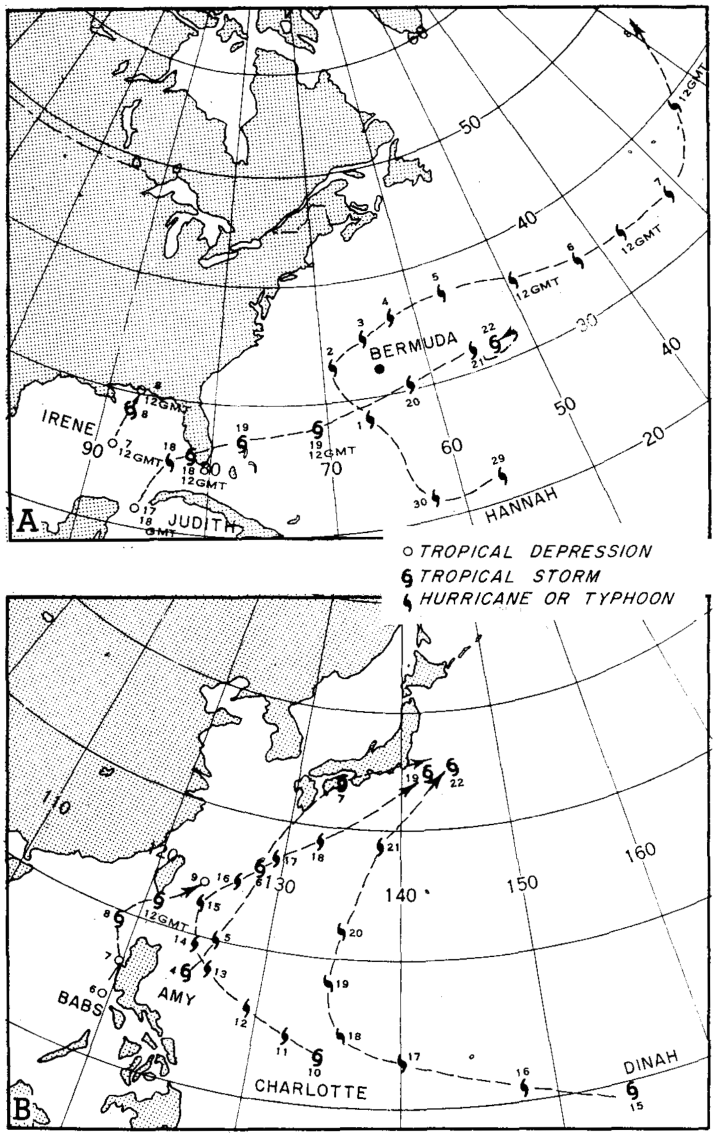


Figure 12.—Tropical storm activity during October 1959 in (A) Atlantic and (B) western Pacific. All positions are for 0000 GMT on the date indicated except for those marked.

Caribbean in October. It therefore seems likely that Judith existed in some stage of development in the western Caribbean before its official discovery in the Yucatan Channel. Judith might have developed into a destructive hurricane had not the westerlies penetrated so far south (fig. 2B). Judith briefly attained hurricane intensity, filled as it crossed southern Florida, and then deepened again in the Atlantic (fig. 12A). It filled east of Bermuda on October 22 when it came under the influence of a large polar anticyclone. Wind damage was slight in southern Florida, but, as in the case of Irene, heavy rains caused some flood damage in the Lake Okeechobee area.

PACIFIC

In the western Pacific four tropical storms were observed, two of which attained typhoon intensity. Three of these storms threatened the southern coast of Japan, but the westerlies were close to their normal position (fig. 5) and farther south than in September, when typhoon damage was very heavy [2]. As a result, the damaging effects of October's storms were decreased as they weakened and became extratropical off the east coast of Japan (fig. 12B).

The tracks of these storms shown in figure 12B were all closely related to the mean trough position (fig. 2) from Korea to the Philippines. Mean conditions over the western Pacific were favorable to tropical storm development; i.e., the subtropical ridge was stronger than normal (fig. 2) and the easterlies were more than 4 m.p.s. above normal (not shown). Conditions for recurvature, as discussed by Hawkins [4], were favorable throughout the month (figs. 2, 3) and helped define the mean storm track. It is interesting to note that only those tropical storms originating in the easterlies, Charlotte and Dinah, developed to typhoon intensity.

A discussion of October's tropical storm activity would not be complete without mention of the destructive storm that struck the west coast of Mexico near Manzanillo, causing widespread damage from heavy rains, high tides, and flash floods. Unfortunately, all analyses of this storm must be deduced from scattered ship reports. This storm appears to have originated as a tropical depression about 250 miles south of the Gulf of Tehuantepec on October 22. It then moved slowly northwestward and deepened until it reached hurricane intensity just south of Manzanillo on the 27th, before moving inland and filling on the 28th. Here, as in Japan in September [2] and in other cases of severe loss of life from tropical storms [5], destruction from floods and disease was far greater than that from hurricane winds.

REFERENCES

1. C. M. Woffinden, "The Weather and Circulation of May 1959—Including an Analysis of Precipitation in Relation to Vertical Motion," *Monthly Weather Review*, vol. 87, No. 5, Sept. 1959, pp. 196–205.
2. J. F. O'Connor, "The Weather and Circulation of September 1959—Quasi-Periodic Oscillations in Zonal Index and Centers of Action," *Monthly Weather Review*, vol. 87, No. 9, Sept. 1959, pp. 357–366.
3. W. H. Haggard, "The Birthplace of North Atlantic Storms," *Monthly Weather Review*, vol. 86, No. 10, Oct. 1958, pp. 397–404.
4. H. F. Hawkins, Jr., "The Weather and Circulation of September 1956—Including a Discussion of Hurricane Flossy and September's Typhoon Tracks," *Monthly Weather Review*, vol. 84, No. 9, Sept. 1956, pp. 336–342.
5. I. R. Tannehill, *Hurricanes*, 9th Rev. Ed., Princeton University Press, 1956, 308 pp.

U.S. GOVERNMENT PRINTING OFFICE: 1960